PATENT APPLICATION
CIMA 3.0-030 CONT II

SUBLINGUAL BUCCAL EFFERVESCENT

CROSS-REFERENCE TO RELATED APPLICATION

The present application is a continuation application of United States Patent Application No. 09/277,424 filed March 26, 1999, now abandoned.

BACKGROUND OF THE INVENTION

The present invention claims the benefit of the United States Provisional Application No. 60/079,652 filed on March 27, 1998, the disclosure of which is incorporated by reference herein.

FIELD OF THE INVENTION

The present invention relates to pharmaceutical compositions, and more particularly to pharmaceutical compositions for oral administration of a medicament, which contain an effervescent agent for enhancing oral drug absorption across the buccal, sublingual, and gingival mucosa.

DESCRIPTION OF PRIOR ART

Effervescents have been shown to be useful and advantageous for oral administration. *See* Pharmaceutical DosageForms: Tablets Volume I, Second Edition. A. Lieberman. ed. 1989, Marcel Dekker, Inc. As discussed in this text, and as commonly employed, an effervescent tablet is dissolved in water to provide a carbonated or sparkling liquid drink. *See* also U.S. Pat. Nos. 5,102,665 and 5,468,504 to Schaeffer, herein

incorporated by reference. In such a drink, the effervescent helps to mask the taste of medicaments.

Effervescent compositions have also been employed for use as taste masking agents in dosage forms which are not dissolved in water prior to administration. For example, U.S. Pat. No. 4,639,368 describes a chewing gum containing a medicament capable of absorption through the buccal cavity and containing a taste masking amount of an effervescent.

More recently effervescents have been employed to obtain rapid dissolution and/or dispersion of the medicament in the oral cavity. *See* U.S. Pat. Nos. 5,178,878 and 5,223,264. The effervescent tends to stimulate saliva production thereby providing additional water to aid in further effervescent action. These dosage forms give an agreeable presentation of the drug, particularly for patients who have difficulty in swallowing tablets or capsules. PCT application WO 97/06786 describes pre-gastric absorption of certain drugs using rapidly-disbursing dosage forms.

Various proposals have been advanced for oral mucosal administration of various drugs. When drugs are absorbed from the oral mucosa, they bypass the gastrointestinal and hepatic metabolism process. This can lead to a faster onset of action and/or improved bioavailability of a drug. However, many compounds do

not rapidly penetrate the oral mucosa. *See*, e.g., Christina Graffner, Clinical Experience with Novel Buccal and Sublingual Administration; NOVEL DRUG DELIVERY AND ITS THERAPEUTIC APPLICATION, edited by L.F. Prescott and W.S. Nimmo (1989); David Harris & Joseph R. Robinson, Drug Delivery via the Mucous Membranes of the Oral Cavity; JOURNAL OF PHARMACEUTICAL SCIENCES, Vol. 81 (Jan. 1992); Oral Mucosal Delivery, edited by M.J. Rathbone, which are herein incorporated by reference. The compounds which may be well absorbed per-orally (through the gastrointestinal tract) may not be well absorbed through the mucosa of the mouth because the oral mucosa is less permeable than the intestinal mucosa and it does not offer as big a surface area as the small intestine.

Despite these and other efforts toward increasing the permeation of medicaments across the oral mucosa, there have been unmet needs for improved methods of administrating medicaments across the oral mucosa.

SUMMARY OF THE INVENTION

The pharmaceutical compositions of the present invention comprise an orally administerable medicament in combination with an effervescent agent used as penetration enhancer to influence the permeability of the medicament across the buccal, sublingual, and gingival mucosa.

DETAILED DESCRIPTION OF THE INVENTION

One aspect of this invention is to use effervescent as penetration enhancers for influencing oral drug absorption. Effervescent agents can be used alone or in combination with other penetration enhancers, which leads to an increase in the rate and extent of absorption of an active drug. It is believed that such increase can rise from one or all of the following mechanisms:

1. reducing the mucosal layer thickness and/or viscosity;

2. tight junction alteration;

3. inducing a change in the cell membrane structure; and

4. increasing the hydrophobic environment within the cellular membrane.

The present dosage forms should include an amount of an effervescent agent effective to aid in penetration of the drug across the oral mucosa. Preferably, the effervescent is provided in an amount of between about 5% and about 95% by weight, based on the weight of the finished tablet, and more preferably in an amount of between about 30% and about 80% by weight. It is particularly preferred that sufficient effervescent material be provided such that the evolved gas is more

than about 5cm^3 but less than about 30cm^3, upon exposure of the tablet to an aqueous environment. However, the amount of effervescent agent must be optimized for each specific drug.

The term "effervescent agent" includes compounds which evolve gas. The preferred effervescent agents evolve gas by means of a chemical reaction which takes place upon exposure of the effervescent agent (an effervescent couple) to water and/or to saliva in the mouth. This reaction is most often the result of the reaction of a soluble acid source and a source of carbon dioxide such as an alkaline carbonate or bicarbonate. The reaction of these two general compounds produces carbon dioxide gas upon contact with water or saliva. Such water-activated materials must be kept in a generally anhydrous state and with little or no absorbed moisture or in a stable hydrated form, since exposure to water will prematurely disintegrate the tablet. The acid sources may be any which are safe for human consumption and may generally include food acids, acid and hydrite antacids such as, for example: citric, tartaric, amalic, fumeric, adipic, and succinics. Carbonate sources include dry solid carbonate and bicarbonate salt such as, preferably, sodium bicarbonate, sodium carbonate, potassium bicarbonate and potassium carbonate, magnesium carbonate and the like.

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Reactants which evolve oxygen or other gasses and which are safe for human consumption are also included.

The effervescent agent(s) of the present invention is not always based upon a reaction which forms carbon dioxide. Reactants which evolve oxygen or other gasses which are safe for human consumption are also considered within the scope. Where the effervescent agent includes two mutually reactive components, such as an acid source and a carbonate source, it is preferred that both components react completely. Therefore, an equivalent ratio of components which provides for equal equivalents is preferred. For example, if the acid used is diprotic, then either twice the amount of a mono-reactive carbonate base, or an equal amount of a di-reactive base should be used for complete neutralization to be realized. However, in other embodiments of the present invention, the amount of either acid or carbonate source may exceed the amount of the other component. This may be useful to enhance taste and/or performance of a tablet containing an overage of either component. In this case, it is acceptable that the additional amount of either component may remain unreacted.

The present dosage forms may also include in amounts additional to that required for effervescence a pH adjusting substance. For drugs that are weakly

acidic or weakly basic, the pH of the aqueous environment can influence the relative concentrations of the ionized and unionized forms of the drug present in solution according to the Henderson-Hasselbach equation. The pH solutions in which an effervescent couple has dissolved is slightly acidic due to the evolution of carbon dioxide. The pH of the local environment, e.g., saliva in immediate contact with the tablet and any drug that may have dissolved from it, may be adjusted by incorporating in the tablet a pH adjusting substances which permit the relative portions of the ionized and unionized forms of the drug to be controlled. In this way, the present dosage forms can be optimized for each specific drug. If the unionized drug is known or suspected to be absorbed through the cell membrane (transcellular absorption) it would be preferable to alter the pH of the local environment (within the limits tolerable to the subject) to a level that favors the unionized form of the drug. Conversely, if the ionized form is more readily dissolved the local environment should favor ionization.

The aqueous solubility of the drug should preferably not be compromised by the effervescent and pH adjusting substance, such that the dosage forms permit a sufficient concentration of the drug to be present in the unionized form. The percentage of the pH adjusting

substance and/or effervescent should therefore be adjusted depending on the drug.

Suitable pH adjusting substance for use in the present invention include any weak acid or weak base in amounts additional to that required for the effervescence or, preferably, any buffer system that is not harmful to the oral mucosa. Suitable pH adjusting substance for use in the present invention include, but are not limited to, any of the acids or bases previously mentioned as effervescent compounds, disodium hydrogen phosphate, sodium dihydrogen phosphate and the equivalent potassium salt.

The active ingredient suitable for use in the present dosage forms can include systematically distributable pharmaceutical ingredients, vitamins, minerals, dietary supplements, as well as non-systematically distributable drugs. Preferably, the active ingredient is a systemically active pharmaceutical ingredient which is absorbable by the body through the oral mucosa. Although the dosage forms can be employed with a wide range of drugs, as discussed below, it is especially suitable for drugs and other pharmaceutical ingredients which suffer significant loss of activity in the lumen of the gastrointestinal tract or in the tissues of the gastrointestinal tract during absorption process or upon passage through the liver

after absorption in the intestinal tract. Absorption through the oral mucosa allows the drug to enter the systemic circulation without first passing through the liver, and thus alleviates the loss of activity upon passage through the liver.

Sub E2

Pharmaceutical ingredients may include, without limitation, analgesics, anti-inflammatories, antipyretics, antibiotics, antimicrobials, laxatives, anorexics, antihistamines, antiasthmatics, antidiuretics, antiflatuents, antimigraine agents, antispasmodics, sedatives, antihyperactives, antihypertensives, tranquilizers, decongestants, beta blockers; peptides, proteins, oligonucleotides and other substances of biological origin, and combinations thereof. Also encompassed by the terms "active ingredient(s)", "pharmaceutical ingredient(s)" and "active agents" are the drugs and pharmaceutically active ingredients described in *Mantelle*, U.S. Pat. No. 5,234,957, in columns 18 through 21. That text of *Mantelle* is hereby incorporated by reference. Alternatively or additionally, the active ingredient can include drugs and other pharmaceutical ingredients, vitamins, minerals and dietary supplements as the same are defined in U.S. Pat. No. 5,178,878, the disclosure of which is also incorporated by reference herein.

The dosage form preferably includes an effervescent couple, in combination with the other ingredients to enhance the absorption of the pharmaceutical ingredient across the oral mucosa and to improve the disintegration profile and the organoleptic properties of the dosage form. For example, the area of contact between the dosage form and the oral mucosa, and the residence time of the dosage form in the oral cavity can be improved by including a bioadhesive polymer in this drug delivery system. *See*, e.g., Mechanistic Studies on Effervescent-Induced Permeability Enhancement by Jonathan Eichman (1997), which is incorporated by reference herein. Effervescence, due to its mucus stripping properties, would also enhance the residence time of the bioadhesive, thereby increasing the residence time for the drug absorption. Non-limiting examples of bioadhesives used in the present invention include, for example, Carbopol 934 P, Na CMC, Methocel, Polycarbophil (Noveon AA-1), HPMC, Na alginate, Na Hyaluronate and other natural or synthetic bioadhesives.

In addition to the effervescence-producing agents, a dosage form according to the present invention may also include suitable non-effervescent disintegration agents. Non-limiting examples of non-effervescent disintegration agents include: microcrystalline, cellulose, croscarmelose sodium, crospovidone, starches,

corn starch, potato starch and modified starches thereof, sweeteners, clays, such as bentonite, alginates, gums such as agar, guar, locust bean, karaya, pecitin and tragacanth. Disintegrants may comprise up to about 20 weight percent and preferably between about 2 and about 10% of the total weight of the composition.

In addition to the particles in accordance with the present invention, the dosage forms may also include glidants, lubricants, binders, sweeteners, flavoring and coloring components. Any conventional sweetener or flavoring component may be used. Combinations of sweeteners, flavoring components, or sweeteners and flavoring components may likewise be used.

Examples of binders which can be used include acacia, tragacanth, gelatin, starch, cellulose materials such as methyl cellulose and sodium carboxy methyl cellulose, alginic acids and salts thereof, magnesium aluminum silicate, polyethylene glycol, guar gum, polysaccharide acids, bentonites, sugars, invert sugars and the like. Binders may be used in an amount of up to 60 weight percent and preferably about 10 to about 40 weight percent of the total composition.

Coloring agents may include titanium dioxide, and dyes suitable for food such as those known as F.D.&C. dyes and natural coloring agents such as grape skin extract, beet red powder, beta-carotene, annato,

carmine, turmeric, paprika, etc. The amount of coloring used may range from about 0.1 to about 3.5 weight percent of the total composition.

Flavors incorporated in the composition may be chosen from synthetic flavor oils and flavoring aromatics and/or natural oils, extracts from plants, leaves, flowers, fruits and so forth and combinations thereof. These may include cinnamon oil, oil of wintergreen, peppermint oils, clove oil, bay oil, anise oil, eucalyptus, thyme oil, cedar leave oil, oil of nutmeg, oil of sage, oil of bitter almonds and cassia oil. Also useful as flavors are vanilla, citrus oil, including lemon, orange, grape, lime and grapefruit, and fruit essences, including apple, pear, peach, strawberry, raspberry, cherry, plum, pineapple, apricot and so forth. Flavors which have been found to be particularly useful include commercially available orange, grape, cherry and bubble gum flavors and mixtures thereof. The amount of flavoring may depend on a number of factors, including the organoleptic effect desired. Flavors may be present in an amount ranging from about 0.05 to about 3 percent by weight based upon the weight of the composition. Particularly preferred flavors are the grape and cherry flavors and citrus flavors such as orange.

One aspect of the invention provides a solid, oral tablet dosage form suitable for sublingual, buccal, and gingival administration. Excipient fillers can be used to facilitate tableting. The filler desirably will also assist in the rapid dissolution of the dosage form in the mouth. Non-limiting examples of suitable fillers include: mannitol, dextrose, lactose, sucrose, and calcium carbonate.

METHOD OF MANUFACTURE

Tablets can either be manufactured by direct compression, wet granulation or any other tablet manufacturing technique. *See*, e.g., U.S. Pat. Nos. 5,178,878 and 5,223,264, which are incorporated by reference herein. The tablet may be a layered tablet consisting of a layer of the active ingredient sandwiched between a bioadhesive layer and an effervescence layer. Other layered forms which include the ingredients set forth above in layers of diverse compositions.

Effervescence Level:	Between 5% - 95%
Tablet size:	Between 3/16" - 5/8"
Tablet hardness:	Between 5N and 80N
Route of administration:	Sublingual, Buccal, Gingival

The dosage form may be administered to a human or other mammalian subject by placing the dosage form in

the subject's mouth and holding it in the mouth, either adjacent a cheek (for buccal administration), beneath the tongue (for sublingual administration) and between the upper lip and gum (for gingival administration). The dosage form spontaneously begins to disintegrate due to the moisture in the mouth. The disintegration, and particularly the effervescence, stimulates additional salivation which further enhances disintegration.

EXAMPLE 1

The dosage form should include Fentanyl, an effervescent and pH adjusting substance so that the pH is adjusted to neutral (or slightly higher) since the pKa of fentanyl is 7.3. At this pH, the aqueous solubility of this poorly water-soluble drug would not be compromised unduly, and would permit a sufficient concentration of the drug to be present in the unionized form.

Two fentanyl formulations, each containing 36% effervescence, were produced. These tablets were compressed using half-inch shallow concave punches.

FORMULATION	COMPONENT	QUANTITY (MG)
SHORT	Fentanyl, citrate, USP	1.57
DISINTEGRATION	Lactose monohydrate	119.47
TIME	Microcrystalline Cellulose, Silicified	119.47
	Sodium carbonate, anhydrous	46.99
	Sodium bicarbonate	105
	Citric acid, anhydrous	75
	Polyvinylphrrolidone, cross-linked	25
	Magnesium stearate	5
	Colloidal silicon dioxide	2.5
	Total tablet mass	**500**
LONG	Fentanyl citrate, USP	1.57
DISINTEGRATION	Lactose monohydrate	270.93
TIME	Sodium carbonate, anhydrous	40.00
	Sodium bicarbonate	105
	Citric acid, anhydrous	75
	Magnesium stearate	5
	Colloidal silicon dioxide	2.5
	Total tablet mass	**500**

EXAMPLE 2

The dosage form included prochlorperazine (pKa=8.1), an effervescent and pH adjusting substance so that a slightly higher pH is produced to facilitate the permeation enhancement.

With respect to prochlorperazine, an anti-emetic drug, two formulations, buccal and sublingual, were developed. The buccal tablets were compressed as quarter inch diameter biconvex tablets, whereas the sublingual tablets were three-eighths inch diameter biconvex tablets. These dimensions were chosen to give a comfortable fit in the respective part of the oral cavity for which they were designed. The formulae for these tablets are as follows:

FORMULATION	COMPONENT NAME	QUANTITY (MG)
BUCCAL	Prochlorperazine	5.00
	Sodium Bicarbonate	15.52
	Citric Acid, Anhydrous	11.08
	Sodium Bicarbonate	45.78
	HPMC K4M Prem	5.00
	Dicalcium phosphate dihydrate	5.00
	Mannitol	11.67
	Magnesium Stearate	0.95
	Total	**100.00**
SUBLINGUAL	Prochlorperazine	5.00
	Sodium Bicarbonate	61.25
	Citric Acid, Anhydrous	43.75
	Sodium Bicarbonate	95
	Sodium carbonate	91.25
	HPMC Methocel K4M Prem	40
	Mannitol	60
	Magnesium Stearate	3.75
	Total	**400**